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Agenda item :

Simulation of Self-synchronized ADS Using UDP/IP network

INFORMATION PAPER

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SUMMARY

The Automatic Dependent Surveillance (ADS) using a satellite has recently been introduced to the oceanic air traffic control for surveillance. ADS reports are transmitted through a data link to an air traffic control center. Air traffic controllers can monitor the positions of aircraft flying over the ocean accurately in real-time using ADS. ADS reports transfer through a data link that meets present ICAO AMSS SARPs suffers a substantial delay and the delay may further increase due to the possible traffic congestion [1]. Thus, we have proposed the self-synchronized ADS using a satellite that promotes more efficient use of channels [2] [3] [4].

An internet protocol (IP) is used in the network of the next generation aeronautical satellite system. This paper presents the results of the simulation of ADS in IP, especially UDP, network. The analysis has shown that the ADS using UDP/IP provides good performances.

1. INTRODUCTION

The Automatic Dependent Surveillance (ADS) using a satellite has recently been introduced to the oceanic air traffic control for surveillance. ADS reports are transmitted through a data link to an air traffic control center. Air traffic controllers can monitor the positions of aircraft flying over the ocean accurately in real-time using ADS. ADS reports transfer through a data link that meets present ICAO AMSS SARPs suffers a substantial delay and the delay may further increase due to the possible traffic congestion [1]. Thus, we have proposed the self-synchronized ADS using a satellite that promote more efficient use of channels [2] [3] [4].

An internet protocol (IP) is used in the network of the next generation aeronautical satellite system. This paper describes the results of simulation of self-synchronized ADS in IP, especially UDP, network.

2. ADS

Figure 1 shows an example of an ADS report format. It is the format specified for R-channel Signal Unit (SU) in the AMSS SARPs. We assume this format in this paper for convenience because it can accommodate the required ADS report items (10 octet) without modification.

Figure 2 shows the concept of self-synchronized ADS using a satellite. In this concept, an air traffic control center sends an ADS report request to each AES in the coverage of a spot beam sequentially. Then, each AES sends back an ADS report to the ground immediately in response to the request. Each AES needs to synchronize to UTC by using an on-board GPS receiver for the self-synchronized ADS.

3. INTERNET PROTOCOL

An internet protocol (IP) is used in the network of the next generation aeronautical satellite system such as the SwiftBroadband network, the Iridium system and so on. Figure 3 shows a frame of IPv4 header. An IP header is composed of the control information for packet distribution. There are UDP (User Datagram Protocol) and TCP (Transmission Control Protocol) in the transport layer over IP. UDP is a connectionless protocol, and is applied in the real time connection. TCP is a connection protocol and has a high reliability. The delay of UDP/IP is less than that of TCP/IP. Figure 4 shows an UDP format.

4. ADS USING UDP/IP NETWORK BASED ON MODIFIED SIMULATOR

4.1 Concept

We simulate a basic protocol of a self-synchronized ADS using IP network by modifying the ADS simulator based on ICAO AMSS standards. The modified points are described as follows.

1) Addition of IP network
   It is used to send or receive ADS report using IP network.
2) Addition of channel rate faster than current channel rate, that is 10.5kbps
   It is used to send or receive the ADS report or ADS report request using IP network. The rate is 19.2kbps, 38.4kbps, 76.8kbps, 153.6kbps

Since the retransmissions of last data are not included in UDP/IP, we assume the ADS with a self-synchronized protocol and UDP.

4.2 Setting of Simulation

*IP network: UDP/IP
*Data length of ADS report: 223octet (T-channel)
*Transmission Periods of ADS report: 64 seconds, 184 seconds
*Channel rate: 10.5kbps, 19.2kbps, 38.4kbps, 76.8kbps, 153.6kbps
*Number of AES: Variable (~2000)
*Configuration of Channel: Psmc =1, Rsmc=1, Pd=1,Rd=1,Td=1
*Number of Simulation trials: 5

4.3 Results of Simulation

Figure 5 shows the results of simulation using UDP packet of IP network when the transmission periods of ADS report is assumed 64 seconds. Each point in the figure represents the averaged value for five trials. Table 1 shows the maximum number of AES for which the 95% transmission delay is less than 60 seconds for the channel rate more than 10.5kbps. Figure 6 shows the results of simulation when the transmission periods are assumed 184 seconds. Table 2 shows the maximum number of AES for which 95% transmission delay is less than 60 seconds for the channel rate more than 10.5kbps.

If the ADS report is transmitted every 64 seconds, the maximum number of AES that the 95% transmission delay is less than 60 seconds is 110 in the case of the channel rate of 10.5kbps. If the channel rate is 153.6kbps under the same situation, the maximum number of AES is 950.

If the ADS report is transmitted every 184 seconds, the maximum number of AES that the 95% transmission delay is less than 60 seconds is 330 in the case of the channel rate of 153.6kbps, the maximum number of AES is over 2000.

5. CONCLUSION

In this paper, we have reported the results of simulation for self-synchronized ADS in IP network. Since ADS is a surveillance system, the performances of delays etc. are required to ensure a reliable and punctual acquisition of aircraft position at an air traffic control center.

Since the retransmissions of last data are not included in UDP/IP, we assumed the ADS with a self-synchronized protocol and UDP.

If the ADS report is transmitted every 64 seconds, the maximum number of AES that the 95% transmission delay is less than 60 seconds is 110 in the case of the channel rate of 10.5kbps. If the channel rate is 153.6kbps under the same situation, the maximum number of AES is 950. If the ADS report is transmitted every 184 seconds in the case of the channel rate of 153.6kbps, the maximum number of AES is over 2000.

References

[1] A.Ishide,"Update on 'Comparison of Transmission Delays for Experiments and Simulation (II)", 16th Meeting of AMCP WG-A, WP-663, January 2000.

[2] Y.Sumiya, A.Ishide,"Concept of Self-synchronized ADS using Satellite," 3rd Meeting of NexSAT, WP-3, October 2003.

[3] Y.Sumiya, A.Ishide, "Concept of Self-synchronized Automatic Dependent Surveillance using Satellite", ACP WG-C7, WP07, April 2004.

[4] Y.Sumiya, A.Ishide, " Self-synchronized ADS in IP network", ACP WG-C11 (NexSAT 8th meeting), WP25, September 2006.

[5] Eurocontrol, "SwiftBroadband Capabilities to Support Aeronautical Safety Services ~WP1: Technical Description and Application to ATS", November 2005

[6] Y.Sumiya, A.Ishide, "Simulation of Self-synchronized ADS using IP network", AGCFG 4th Meeting /NexSAT 9th Meeting, September 2007.

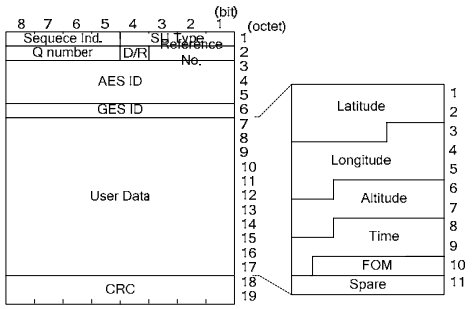

Figure 1. ADS Report Format

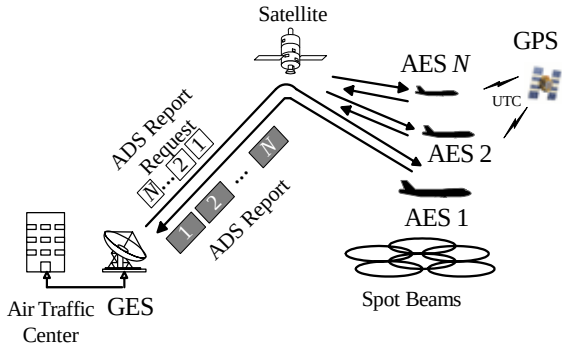

Figure 2. Concept of self-synchronized ADS

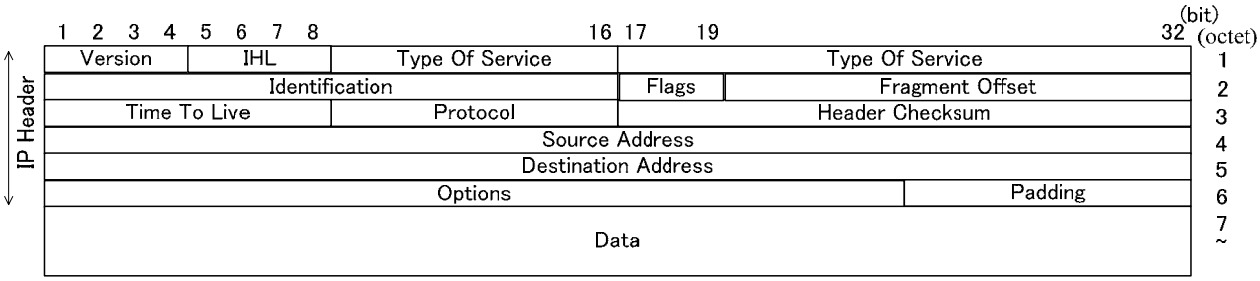

Figure 3. Internet Protocol version 4 (IPv4) Header Format

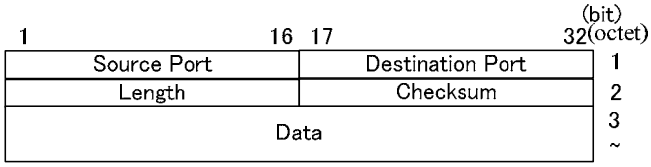

Figure 4. UDP Header Format

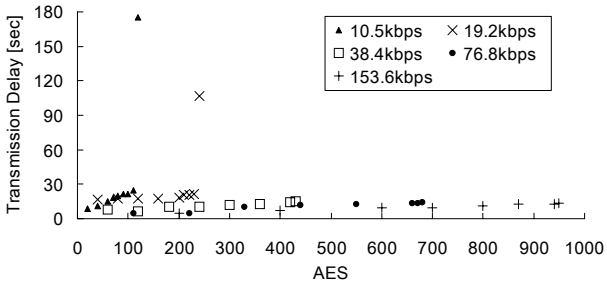

Figure 5. 95% Transmission Delay
(Transmission periods : 64 seconds)

Table 1 Maximum AES satisfied by 95% Transmission Delay less than 60seconds in the case of channel rate more than 10.5kbps
(Psmc=1,Rsmc=1,Pd=1,Rd=1,Td=1)

Channel Rate	Maximum AES
10.5kbps	110
19.2kbps	230
38.4kbps	430
76.8kbps	680
153.6kbps	950

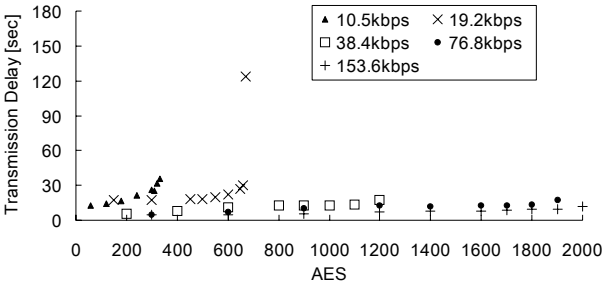

Figure 6. 95% Transmission Delay
(Transmission periods : 184 seconds)

Table 2 Maximum AES satisfied by 95% Transmission Delay less than 60seconds in the case of channel rate more than 10.5kbps
(Psmc=1,Rsmc=1,Pd=1,Rd=1,Td=1)

Channel Rate	Maximum AES
10.5kbps	330
19.2kbps	660
38.4kbps	1200
76.8kbps	1900
153.6kbps	2000